IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Thomas Y-T. Tam et al.   Group Art Unit: 1732

Serial No: 10/699,416   Examiner: Patrick Butler

Filed: October 31, 2003

File No. H0004478 (4820)

For: PROCESS FOR DRAWING GEL-SPUN POLYETHYLENE YARNS

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

SUPPLMENTAL DECLARATION UNDER 37 CFR § 1.132

I, Sheldon Kavesh, declare as follows:

I have again reviewed United States patent application Serial Number 10/699,416, filed October 31, 2003, which has been published as United States Patent Publication 20050093200 (the "Application"), the Office Action dated November 16, 2006 in the Application and the references that were applied against the claims of the Application. I have also reviewed the Final Rejection dated May 3, 2007. I have been asked to respond to the following questions in relation to the comments that were made in the Final Rejection.

1. What is the ratio of the heat transfer rate in a turbulent air flow to that in a laminar air flow over the temperature range 130°C to160°C?

2. Does Suwanda et al. USP 5,505,900 teach stretching of fibers in a turbulent flow regime?

3. Is it predictable from USP 4,551,296 or from the combination of that patent with Bory et al., US 4,248,577 that the mass throughput of stretched polyethylene fibers could exceed 0.25 g/min?

4. In Example 533 and Example 529 of USP 4,551,296, could the first stage draw ratio have been increased?

5. Is the feature of Claim 32 of the Application shown by Example 523 of USP 4,551,296?

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6. Are the mass throughputs achieved in the Application what would be expected by one of ordinary skill in the art?

In response, I state as follows:

1. In my Declaration of Jan 10, 2007, an Appendix was included that showed the heat transfer coefficient for air in a turbulent flow regime as a ratio to that of air in a laminar flow regime at a temperature of 151°C. In the Final Rejection, the point was raised that the previous calculation was only for a single temperature as opposed to the temperature range of 130°C to 160°C that is claimed in the Application. In response, an Appendix attached to this Declaration shows a calculation of the same ratio at temperatures of 130°C, 145°C and 160°C. It will be seen that the over the temperature range of 130°C to 160°C, the heat transmission rate in a laminar flow regime is about an order of magnitude lower than in a turbulent flow regime. The ratio differs slightly from that presented in my earlier Declaration because less rounding was used in the calculations here.

2. Regarding the presence of turbulent flow in forced convection, Perry's Chemical Engineers' Handbook. Sixth Edition at P. 10-14, Forced Convection, first paragraph says that, "Flow is generally turbulent..." (emphasis added). However, attention is also called to Perry, P. 10-15, Laminar Flow, first paragraph, which states that "Normally, laminar flow occurs in closed ducts when $N_{Re} < 2100...$". Suwanda et al. USP 5,505,900 includes no disclosure that would enable me to reach any conclusion as to whether the forced air flow in oven 26 was in a turbulent flow regime or in a laminar flow regime. However, what can be said is that Suwanda et al. does not teach turbulent flow as that term is nowhere used or implied in Suwanda et al., and such is not inherent to the disclosure. In my opinion, Suwanda et al. does not teach or suggest to one having ordinary skill in the art that the flow is a turbulent flow.

3. In my view it is not predictable from USP 4,551,296 that the mass throughput of stretched polyethylene fibers could exceed 0.25 g/min as called for in the claims of the Application. The Final Rejection takes as a basis the 0.06 g/min mass throughput for the 48 filament yarn of Example 533 of that patent. The mass throughput for 240 filaments is

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considered in the Final Rejection to be in simple proportion to the number of filaments, and so a mass throughput of 240/48 x 0.06=0.30 g/min is said to be taught by Example 533 of the '296 patent. Yet further, the Final Rejection combines that calculation with the Bury et al., USP 4,248,577 description of a 3750 hole spinneret to suggest that a mass throughput of 0.3 g/min*3750 filaments in new spinneret/240 filaments = 4.7 g/min would be expected.

As noted in my earlier Declaration, it is my experience that mass throughput in a drawing process does not increase in simple proportion to the number of filaments. This may also be inferred from the following published information. Attached is a data sheet for Honeywell International's SPECTRA® 900 high strength polyethylene fiber. It will be seen that the yarn tenacity (ultimate tensile strength) for comparable products decreased from 30.5 g/d to 25.5 g/d as the number of filaments/tow (filaments/yarn end) increased from 60 to 480. SPECTRA® 900 fiber is known to be produced by in-line spinning and drawing so that the yarn linear speed increases at every stage of drawing. Yarn tension increases with increased drawing speed. The fact that tenacity decreased as filament count increased is an indication that it was necessary to run the higher filament count yarns at lower stretch ratios, i.e., at lower final line speeds in order to avoid breakage. Lower line speeds means that mass throughput did not increase in simple proportion to filament count.

It is posited in the Final Rejection that even if slowed, USP 4,551,296, Example 533 would still yield a scaled up production rate for 240 filaments of more than the claimed amount of at least 0.25 g/min, and that the combination of USP 4,551,296 with Bury et al. would yield a production rate of 4.7 g/min. In my opinion, there is nothing in USP 4,551,296, Bury et al., or elsewhere to support these conclusions, and this is contrary to my experience and opinion.

4.   In the Final Rejection the position is taken with respect to claims 9 and 20 of the Application that it would be obvious to increase the stretching in Example 523 of USP 4,551,296 so as to obtain higher feed yarn tenacity in Example 533, as well as to obtain higher feed yarn tenacity in Example 529.

In my previous declaration I stated that draw ratio in Example 523 of the '296 patent was the maximum that could be run without filament breakage. To explain further, we had arrived at the 10/1 stretch ratio in Example 523 by starting at a lower stretch ratio and then

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increasing the stretch ratio gradually in steps until the yarn broke. At stretch ratios greater than 10/1, yarn breakage occurred almost immediately. Higher draw ratios in Example 523 were not possible.

5.   The comments in the paragraph bridging pages 12 and 13 of the Final Rejection seem to be contradictory. On the one hand, it is stated that if the feed yarn (for Example 529?) were not essentially undrawn, then any subsequent drawing would destroy the fiber. On the other hand, it is noted that even more drawing (of the same feed fiber?) was done as in Example 533.
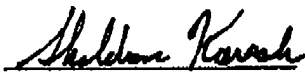
The feed yarn for Example 529 was indeed previously drawn to prepare Example 523 as described at Col. 26, lines 12-23 of the '296 patent. The yarn of Example 523 was of 392 denier (g/9000m). The mass throughput during the preparation of the yarn of Example 523 was therefore 392 g/9000m x (0.35 m/min feed speed x 10 draw ratio) = 0.15 g/min. This is less than the amount of 0.5 g/min that is claimed in claim 29 from which claim 32 depends. Consequently, Example 523 does not disclose the features of claim 32.

6.   As I previously stated, I was very surprised by the high mass throughputs that were achieved in the Application. The high mass throughputs evidently reflect higher heat transfer rates to the yarns and more uniform yarn temperatures as a result of drawing in a turbulent forced convection regime in air than I was able to obtain by tube drawing in essentially quiescent nitrogen. High mass throughputs provide a significant and practical advantage to the manufacturer in higher productivity and lower costs. In my opinion, the effect demonstrated in the Application is unexpected.

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      I certify that all statements made in this declaration made of my own knowledge are true and all statements made on information and belief are believed to be true.

      Willfully false statements and the like are punishable by fine or imprisonment, or both [18 U.S.C. 1001] and may jeopardize the validity of the application or any patent issuing thereon.

Sheldon Kavesh   JUNE 22, 2007

Sheldon Kavesh, Ph.D.   Date

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APPENDIX

Reference: "Perry's Chemical Engineers Handbook, Sixth Ed.", McGraw Hill Book Co., New York, 1984

I. Heat Transfer Under Laminar Flow in a Circular Tube, Constant Wall Temperature

The Nusselt Number is defined as hD/k.   (Perry, P. 10-5)

      where: h is the coefficient of heat transfer, cal/sq. cm-°C-sec

          D is the diameter of the yarn bundle, cm

          k is the thermal conductivity of air, cal/sq.cm-°C-sec/cm

In a laminar flow regime,

Nusselt Number (N_{Nu}) = 3.66   (Perry, Table 10-4, P. 10-15)

II. Heat Transfer Under Turbulent Flow in a Circular Tube Oven, Constant Wall Temperature

In a turbulent flow regime,

$$N_{Nu} = 0.023 \, (N_{Re})^{0.8} \, (N_{Pr})^{1/3} (\mu_b/\mu_w)^{0.14} \text{ for } N_{Re} > 10,000 \qquad \text{(Perry, Eq. 10.50, P. 10-16)}$$

      where: N_{Nu} is defined as above.

          N_{Re} is the Reynolds Number of the flow.

          N_{Pr} is the Prandtl Number of the heat transfer medium (air)

          μ_b, μ_w are the viscosity of the heat transfer medium at the bulk temperature and at the wall temperature.

          Prandtl Number (N_{Pr}) for air @ 130 °C =0.694   (Perry, Table 3-316) $(N_{Pr})^{1/3}$ =0.8854

          Prandtl Number (N_{Pr}) for air @ 145°C =0.693   " $(N_{Pr})^{1/3}$ =0.8849

          Prandtl Number (N_{Pr}) for air @ 160°C =0.692   " $(N_{Pr})^{1/3}$ =0.8845

          Viscosity Ratio (Bulk/Wall)$(\mu_b/\mu_w) \approx 1$

Substituting in Perry Eq. 10-50, we have

      $N_{Nu} = hD/k > 0.023 \times (10,000)^{0.8} \times 0.8854 = 32.28$ @ 130 °C

          $> 0.023 \times (10,000)^{0.8} \times 0.8849 = 32.26$ @ 145 °C

          $> 0.023 \times (10,000)^{0.8} \times 0.8845 = 32.24$ @ 160 °C

The ratio of the turbulent/laminar Nusselt numbers is:

        $(hD/k)_{turbulent}/ (hD/k)_{laminar} > 32.28/3.66 > 8.82$ @ 130 °C

        $(hD/k)_{turbulent}/ (hD/k)_{laminar} > 32.26/3.66 > 8.81$ @ 145°C

        $(hD/k)_{turbulent}/ (hD/k)_{laminar} > 32.24/3.66 > 8.81$ @ 160°C

Therefore, for constant yarn bundle diameter and at the same temperature (k=constant),

     $h_{turbulent}/h_{laminar} > 8.8$

        i.e., the heat transfer coefficient is at least about an order of magnitude greater in a turbulent flow regime than in a laminar flow regime over the whole temperature range from 130 °C to 160°C.

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TABLE 3-314 Thermal Conductivity of Gases*
To obtain conductivity in watts per meter-kelvin, multiply by 10^{-2}.

Temp. °K.	Air	NH₃	Ar	CCl₄	CO₂	C₆H₆	He	H₂	Kr	CH₄	Ne	N₂	O₂	H₂O	X.
100	0.93	...	0.68	...	...	...	7.2	6.7	...	1.08	2.19	0.96	0.93		
150	1.38	...	0.98	...	...	...	9.5	10.1	0.50	1.84	3.04	1.39	1.38		
200	1.80	1.53	1.26	...	0.94	...	11.5	13.1	0.68	2.17	3.62	1.83	1.83	...	
250	2.21	1.96	1.52	...	1.30	2.15	13.4	15.7	0.80	2.75	4.29	2.22	2.26	61	
300	2.62	2.47	1.77	0.69	1.66		15.1	18.3	1.00	3.42	4.89	2.59	2.66		
350	3.00	3.04	2.00	0.85	2.04	2.84	16.6	20.4	1.13	4.00	5.48	2.93	2.98	67	
400	3.38	3.70	2.22	1.01	2.43	3.58	18.4	22.5	1.26	4.93	6.01	3.27	3.30	2.68	
450	3.73	4.20	2.44	1.16	2.83	4.36	20.1	24.7	1.38	5.79	6.53	3.59	3.63	3.10	
500	4.07	5.25	2.66	1.30	3.25	...	21.8	26.6	1.51	6.68	7.03	3.89	4.12	3.58	
600	4.69	6.70	3.07	1.44	4.07	...	25.0	30.5	1.73	8.52	7.97	4.46	4.73	4.83	
700	5.24	...	3.41	1.58	4.81	...	27.8	34.2	1.93	10.46	8.86	4.98	5.28	5.81	
800	5.73	...	3.74	...	5.51	...	30.4	37.8	2.21	...	9.71	5.48	5.89	7.08	
900	6.20	...	4.06	...	6.18	...	33.0	41.2	2.42	...	10.53	5.97	6.49	8.41	
1000	6.67	...	4.4	...	6.82	...	35.4	44.8	2.62	...	11.34	6.47	7.10	9.78	
1200	7.63	...	4.9	...	8.0	...	40.5	52.8	2.98	...	12.16	7.8	8.2	...	

*Condensed from Vargaftik et al., *Heat Conductivity of Gases and Liquids*, FTD-MT-24-193-71 (AD 735963), 1971. The Russian original appeared in
This source contains 256 references.

TABLE 3-315 Viscosity of Sucrose Solutions*
Viscosity in centipoises

Temp. °C.	Percentage sucrose by weight			Temp. °C.	Percentage sucrose by weight		
	20	40	60		20	40	60
0	3.818	14.82		50	0.974	2.506	14.06
5	3.166	11.60		55	0.857	2.227	11.71
10	2.662	9.830	113.9	60	0.811	1.989	9.87
15	2.275	7.496	74.9	65	0.745	1.785	8.37
20	1.967	6.223	56.7	70	0.688	1.614	7.18
25	1.710	5.206	44.02	75	0.637	1.467	6.22
30	1.510	4.398	34.01	80	0.592	1.339	5.42
35	1.336	3.776	26.62	85	0.552	1.239	4.75
40	1.197	3.261	21.30	90	.....	1.127	4.17
45	1.074	2.858	17.24	95	.....	1.041	3.73

**"International Critical Tables," vol. 5, p. 23. Bingham and Jackson,
Bur. Standards Bull. 14, p. 59, 1919.

TABLE 3-316 Prandtl Number of Air*

Temperature, K	Pressure, bar										
	1	5	10	20	30	40	50	60	70	80	90	100
80	mh	2.51	2.32	2.35	2.37	2.40	2.42	2.45	2.48	2.51	2.54	2.57
90	0.796	1.76	1.77	1.78	1.79	1.81	1.82	1.83	1.85	1.87	1.89	1.91
100	0.786	0.972	1.54	1.53	1.53	1.53	1.53	1.53	1.53	1.54	1.54	1.55
120	0.773	0.813	0.89	1.44	1.65	1.54	1.48	1.43	1.40	1.38	1.36	1.34
140	0.763	0.782	0.82	0.94	1.20	1.59	2.14	2.43	2.07	1.73	1.62	1.52
160	0.754	0.765	0.78	0.84	0.92	1.03	1.13	1.25	1.37	1.65	1.83	1.72
180	0.745	0.754	0.763	0.792	0.830	0.875	0.932	1.00	1.07	1.14	1.20	1.65
200	0.738	0.743	0.749	0.765	0.788	0.812	0.841	0.87	0.90	0.95	0.97	1.00
240	0.724	0.727	0.729	0.737	0.746	0.756	0.767	0.78	0.80	0.81	0.81	0.82
280	0.710	0.711	0.713	0.717	0.721	0.726	0.731	0.737	0.742	0.75	0.75	0.76
300	0.705	0.707	0.708	0.712	0.715	0.717	0.721	0.725	0.728	0.732	0.737	0.742
350	0.699	0.699	0.699	0.701	0.703	0.705	0.707	0.709	0.711	0.712	0.714	0.716
400	0.694	0.694	0.694	0.695	0.696	0.697	0.698	0.699	0.700	0.701	0.703	0.704
450	0.691	0.691	0.691	0.691	0.692	0.692	0.693	0.693	0.694	0.695	0.695	0.696
500	0.689	0.689	0.689	0.689	0.689	0.690	0.690	0.690	0.690	0.691	0.691	0.691
600	0.690	0.690	0.690	0.689	0.689	0.689	0.689	0.689	0.689	0.690	0.690	0.690
700	0.696	0.696	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695
800	0.705	0.704	0.704	0.704	0.704	0.703	0.703	0.703	0.703	0.702	0.702	0.702
900	0.709	0.709	0.708	0.708	0.708	0.708	0.708	0.708	0.708	0.708	0.708	0.708
1000	0.711	0.711	0.711	0.711	0.711	0.710	0.710	0.710	0.710	0.710	0.709	0.709

*Compiled by P. E. Liley from tables of specific heat at constant pressure, thermal conductivity, and viscosity given in SI units for integral kelvin temperatures and pressures in bars by Vasserman, *Thermophysical Properties of Air and Its Components* and *Thermophysical Properties of Liquid Air and Its Components*, Nauka, Moscow, and in translated form by the National Bureau of Standards, Washington. The number of significant figures given above reflects the similar numbers appearing for the constituent properties in the source references. While reasonable agreement occurs for atmospheric pressure with some other works, the fragmentary data available for the saturated, etc., states show large deviations.

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Spectra® fiber 900

HIGH-STRENGTH, LIGHT-WEIGHT POLYETHYLENE FIBER

Spectra® fiber 900 was the first commercially available extended-chain, high-strength polyethylene fiber and the first in a series of Spectra® fibers. Spectra® fiber has one of the highest strength-to-weight ratios of any man-made fiber. Its high tenacity makes it, pound for pound, 10 times stronger than steel, more durable than polyester and gives it a specific strength that is 40 percent greater than that of aramid fiber. Specific performance is dependent upon denier and filament counts.

Applications:

- Marine ropes
- Commercial fishing nets
- Industrial cordage & slings
- Law-enforcement & military helmets
- Cut-protection products

Product Characteristics:

- Light enough to float (0.97 specific gravity)
- High resistance to chemicals, water and ultraviolet light
- Excellent vibration damping
- Highly resistant to flex fatigue
- Low coefficient of friction
- Good resistance to abrasion
- Low dielectric constant makes it virtually transparent to radar

Physical Properties

(Nominal)		Spectra® fiber 900				
Weight/Unit Length	(Denier)	650[n]	650	1200	1600	4800
	(Decitex)	722	722	1333	1778	5333
Ultimate Tensile Strength	(g/den)	28	30.5	30	27	25.5
	(Gpa)	2.40	2.61	2.57	2.31	2.18
Breaking Strength	(lbs.)	40.1	44	79	95.2	270
Modulus	(g/den)	775	920	850	718	785
	(Gpa)	66	79	73	62	67
Elongation	(%)	4.1	3.6	3.9	4.4	3.9
Density	(g/cc)	0.97	0.97	0.97	0.97	0.97
	(lbs/in³)	0.035	0.035	0.035	0.035	0.035
Filament/tow		60	60	120	150	480
Filament	(dpf)	10.8	10.8	10.0	10.7	10.0

[n] Designed for knitted cut-resistant products

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For more information, contact us:

Toll Free: +1-800-695-5969
Europe: +33 3 82 44 80 00
Asia: +91 80 5128 9919
Web site: www.spectrafiber.com